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Academics' and Students' Perceptions of the Effect of the Physical Environment on Learning

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Abstract:

Do school and classroom spaces enhance or detract from the learning process? Are lecturers and students as much concerned about their learning environment as is sometimes assumed? Drawing on the work of Fleming and Storr (1999), as well as the theoretical work of, inter alia, Lang (1996) and Bligh (1972), the researchers sought the perceptions of academic staff and students on all six campuses of the University of South Australia.

The following four questions were addressed:

1. What components of lecture theatres do **lecturers** perceive as being important in terms of their effect on students' learning experience?
2. What components of lecture theatres do **students** perceive as being important in terms of their effect on their own learning experience?
3. Do the responses to a general question on the perceived importance of lecture theatre design components differ significantly from responses to the question that considers the learning experience of the student? Are any differences able to be explained?
4. Do the responses of the lecturers and the students differ significantly? Are these differences able to be explained?

The methodology adopted was a combination of focus groups and questionnaire surveys administered to randomly selected groups of students in tutorials and to all academic staff by e-mail. Responses were such that some significant and interesting conclusions were able to be drawn.

Introduction:

Historically, facilities managers in Australian Universities have embarked on construction and refurbishment projects with little input from the users (Radloff, 1999; Jamieson, Fisher, Gilding, Taylor and Trevitt, 2000). As espoused in Strategic Asset Management texts, facilities exist as a means to serve the organisation's ends. Teaching spaces ultimately exist to support educational institutions' service delivery (student learning) and any approach to their design, refurbishment and construction should be guided by this imperative. When input has been sought, it has been primarily the academic staff who have contributed. It would seem appropriate that to truly meet users' needs – to enhance teaching and learning - the input of all users should be sought, including the students.

Whilst the recent literature regarding new learning environments presents 'principles of design' to enhance learning experience, the principles appear to be largely based on the authors' experience with little empirical evidence to suggest that implementing the principles will in fact have any effect on students' learning experience. Flemming and Storr (1999) however, attempted to synthesise design variables and their perceived effect on students' learning experience. Whilst their research was primarily aimed at investigating a phenomenological view of benchmarking facilities in which they used students as surrogate building occupiers, their research also provided the opportunity to evaluate links with the educational literature. More specifically, they investigated students' perceptions with regard to the effect of various lecture theatre design variables on students' learning experience. However, they did not investigate the opinions of the academic staff and limited their research to one type of facility.

As institutions are primarily involved in teaching and learning, clearly the emphasis on students' learning experience is of paramount importance. However to seek users' input into construction and refurbishment projects on this basis alone may be to the detriment of the overall functionality of the space. For example there may be design elements that do not directly support students' learning experience but may make the facility more amenable. Perhaps these elements would also be useful in benchmarking facilities performance? This raises the question of whether users would respond differently if they were asked what design elements they consider to be important in teaching facilities generally as opposed to what they perceive will affect students' learning experience. After all, optimising students' learning experience may be so entrenched in the minds of academic staff and students that the questions may elicit similar responses.

This study sought to answer the aforementioned questions by expanding on Flemming and Storr's (1999) research. While similarly considering the perceived effect of design variables on students' learning experience, this study also sought to investigate more generically which design variables the users consider to be important in both lecture theatres and tutorial rooms. The results and analysis were used to provide facilities managers in the University of South Australia with important information regarding which design variables the users consider are more closely aligned to students' learning experience and where emphasis can be placed to optimise user satisfaction and best support service delivery.

Designers' versus Users' Perspectives

There is a significant amount of literature available regarding the technical aspects of learning environment design, with a number of Australian Universities, for example Griffiths University, University of Technology Sydney and Flinders University, having distilled the literature to form their own specifications**.**

The design literature, for example Owu (1991), Bunn (1997), Carolin (1996), appears to be informed by space design theory, which has its roots in architecture, building and psychology. However, it does not appear that the design-based literature has considered students' learning experience in a systematic and comprehensive manner.

The educational perspective taken by researchers such as Lang (1996), Bligh (1972), Blackett & Stanfield (1994), Jamieson et al (2000), appears to offer a greater insight into the pedagogy/place nexus, especially in view of the increasing use of information technology in the delivery of tertiary education. The last point raises the obvious question of whether teaching spaces and traditional universities will be made redundant by the use of information technology, as is claimed by IT's more enthusiastic proponents. The experience of retail shopping centres, which were to have been replaced by home shopping, and office buildings, which were to have been made redundant by telecommuting are instructive in this regard. The new technologies, while being taken up enthusiastically, appear to complement rather than to supplant their place-based equivalents. Evangelistic prediction of the demise of universities, shopping centres and office buildings appears to deny the fundamental social nature of human beings. The study of teaching spaces in an effort to improve them would still appear to be a fruitful occupation.

Studies seeking user input have been carried out in the United States for decades (Owu 1991; Babey 1991). This is much less common in Australia (Jamieson et al 2000; Radloff 1998). Certainly there is demonstrable worth in such an approach and not just from the perspective of teaching and learning. For example Owu (1991) cites an example at Massachusetts Institute of Technology whereby upgrading one lecture theatre and installing the latest audiovisual equipment reduced seat numbers but increased comfort and led to the space being in high demand**.**

Research Questions

The research questions that were addressed by the study are as follows:

- What components of teaching and learning environments do users consider to be important?
- What components of teaching and learning environments do users perceive as being important in terms of their effect on students' learning experience?
- Do students and academic staff differ in their opinions on the above?
- Do the responses to the generic question on teaching facilities and those to the question which considers students' learning experience differ significantly? Are these differences able to be explained?

Methodology

As the research was essentially a case study of the University of South Australia, it is necessary to provide a brief overview of the research setting. The University of South Australia (UniSA) is South Australia's largest University having over twenty six thousand students and one thousand eight hundred staff (789 academic and 1,037 general staff). The University staff and student population is spread over five metropolitan and one country campus. UniSA is divided into four academic divisions and four coordinating administrative portfolios.

Consistent with the methodology undertaken by Flemming and Storr (1999), the research method was undertaken in two stages. Stage one involved coordinating a focus group whose role was to determine an exhaustive list of room components (design variables) integral to learning environments. These variables then formed the basis of the questionnaire administered in stage two.

Focus Group

Membership to the focus group was sought from a cross section of staff and students so that the interests of all stakeholders were represented in the selection of the design variables. Hence the following people were invited to attend the focus group meeting:

- The Deans of Teaching and Learning from each division
- Campus Services Managers
- A representative from the Flexible Learning Centre
- A post graduate student representative
- An undergraduate student representative
- An onshore overseas student representative
- Manager: Operations and Projects (University Architect)

Both the literature and Flemming and Storr's (1999) research (with slight departures) informed the discussion and subsequent choice of variables. As the study was primarily concerned with the physical environment, the intangible aspects were not considered to be relevant. There was a further departure from the design variables used in Flemming and Storr's (1999) study as the focus group participants considered it appropriate to disaggregate the audio visual elements into their constituent parts.

Table 1 below details all design elements emanating from the focus group discussions.

Table 1

Design Elements

1. Acoustic quality of room
2. Active data points
3. Air conditioning
4. Amount of personal seating space
5. Amount of personal writing space
6. Appropriateness of size
7. Artificial lighting
8. Audio quality of audio visual equipment
9. Ceiling height
10. Clock
11. Ease of accessibility to chair
12. Ease of accessibility to room
13. Flexibility
14. Internal finishes (colour)
15. Internal finishes (type)
16. Lighting control
17. Natural lighting
18. Notebook computer / data projector
19. Over head projector
20. Position of lectern
21. Seating comfort
22. Shape of room
23. Television / Video cassette recorder
24. Tiered Seating
25. Ventilation
26. Visual quality of Audio visual equipment

Whilst most elements can be related equally to lecture theatres and tutorial rooms, the focus group participants considered that tiered flooring inherently relates to lecture theatres whereas flexibility primarily relates to the ability to reconfigure space, something that is more applicable to tutorial rooms. Hence the design variables for the lecture theatres did not include flexibility whereas the design variables for tutorial rooms did not incorporate tiered flooring.

Questionnaire

The questionnaire comprised three sections. Section 1 sought information regarding participants' user category (academic staff, students, both), primary campus of teaching / learning and division. These details were sought to facilitate further analysis, the latter with respect to the success of stratifying the population to ensure all campuses and divisions were represented.

Section 2 comprised questions specifically relating to participants' preferences and perceptions with regard to the various design elements in lecture theatres and tutorial rooms. In terms of the research design being able to address the research questions, clearly two questions were required. Firstly, participants needed to be asked what design elements they considered to be important in terms of their perceived effect on students' learning experience and secondly, what design elements they considered to be important in terms of the facilities / features of teaching facilities generally. As participants' perceptions regarding the general features of rooms may differ depending on the nature of the room, it was decided to ask this question separately in relation to both lecture theatres and tutorial rooms. However it was not considered necessary to separate the rooms when asking participants about the perceived effect on students' learning experience as it is reasonable to expect that what enhances or detracts from students' learning experience will do so in either facility.

Therefore, consistent with the research undertaken by Flemming and Storr (1999), participants were given a list of variables and were requested to indicate how important they considered each to be with respect to the:

- Facilities / features of lecture theatres generally;
- Facilities / features of seminar (tutorial) rooms generally; and
- Effect on student's learning experience.

Respondents rated the importance of the individual variables on a seven point Likert scale ranging from very important (1) to not important (7). Section 2 also included questions regarding user preferences for seating and writing surfaces. Seating and writing surfaces were isolated as opposed to other design variables as they are non technical in nature with participants having sufficient experience to make informed decisions, and much of the furniture in the University is nearing the end of its life cycle with the replacement of such imminent.

Section 3 was optional, providing respondents with the opportunity to comment on the general teaching facilities at UniSA, and areas not otherwise addressed in the questionnaire. It also provided the opportunity for content analysis to be undertaken, potentially identifying critical issues.

Population Sampling, Questionnaire Administration and Response

The population from which the sampling frame was determined is approximately twenty seven thousand people. Given the time constraints on this study, the population was entirely too large to survey all elements and therefore random sampling was employed. Furthermore, given the disproportionate number of academic staff and students in the University and as the research called for a comparison of the responses between the parties, the population was stratified.

Academic staff questionnaires were distributed via e-mail, with the survey as an attachment. In the event that academic staff wished to protect their anonymity or if for whatever reason they were unable to reply electronically, they were asked to print out the questionnaire and return it in the University's internal mail. As the number of respondents from the initial sample was poor, it was subsequently decided to survey all academic staff (excluding those members primarily engaged in research based activities) in an endeavour to obtain a significantly larger number of responses.

The questionnaire was administered to students in hard copy format as opposed to electronically, because the researchers did not have access privileges to the student information on the UniSAinfo database, and because students do not have the same level of access as the academic staff to the electronic medium. It was decided to recruit academic staff members to administer the questionnaire to their students. Consistent with the ethics approval, this was undertaken at the end of selected tutorial group sessions.

Once the survey questionnaires had been completed the data was entered into SPSS. The data was thoroughly checked for errors with amendments made as required. Where questionnaires were incomplete, only the completed data was entered with further analysis being based only on those sections that had been completed.

In total, there were three hundred and thirty two (332) respondents to the questionnaire. The majority (205 or 62%) of respondents were students with 38% (127) being academic staff members. The number of respondents by campus and by division was proportionate to those of the entire population, in accordance with the stratification method adopted.

Results

Although many forms of analysis were appropriate for this type of study, a simple descriptive statistical approach was adopted, consistent with the approach undertaken by Flemming and Storr (1999).

Critical Components of Lecture Theatres

As is seen in Table 2, with respect to the design variables in lecture theatres, the importance and the priorities in ranking differ between the staff and students. Whilst there is some consistency in those variables considered least important (by rank), there are clear discrepancies amongst the higher ranked design elements. Where staff members tended to consider audio-visual elements most important, students focused on factors such as air-conditioning and ventilation, writing and seating space, and seating comfort. Clearly both academic staff and students tended to focus on their immediate environment and 'the tools of the trade'.

It is important to note however that (with the exception of students' opinion of the importance of ceiling height) all variables had a mean score lower than 4. This indicates that on average, all design elements are considered to be, at the very least, somewhat important. Also of note is the standard deviation of the academic staff members highest ranked variables with standard deviations ranging from 0.45 –0.69 for the design variables ranked 1-3 inclusive. These are significantly lower than the standard deviations for the other variables indicating a relative consistency of responses amongst academic staff members with regard to the critical importance of these design elements.

Table 2

	Academic Staff (N=126)			Students (N=202)		
Design Variable	**Rank**	**Mean**	**Std Dev**	**Rank**	**Mean**	**Std Dev**
Visual quality of Audio visual equipment	1	1.25	0.45	6	1.99	1.11
Over head projector	2	1.29	0.68	11	2.39	1.25
Acoustic quality of room	3	1.36	0.69	9	2.23	1.41
Audio quality of audio visual equipment	4	1.44	0.82	5	1.87	1.03
Ventilation	5	1.56	0.83	2	1.70	1.02
Air conditioning	6	1.59	1.01	1	1.68	0.95
Appropriateness of size	7	1.60	0.89	8	2.17	1.17
Lighting control	8	1.68	0.94	13	2.50	1.27
Ease of accessibility to room	9	1.80	1.07	14	2.50	1.28
Artificial lighting	10	1.85	1.14	10	2.38	1.19
Ease of accessibility to chair	11	1.87	1.11	12	2.45	1.29
Amount of personal writing space	12	1.93	0.96	4	1.84	0.95
Seating comfort	13	1.99	1.05	3	1.79	0.97
Television / Video cassette recorder	14	2.05	1.32	20	2.94	1.39
Amount of personal seating space	15	2.10	1.05	7	2.02	0.98
Notebook computer / data projector	16	2.14	1.52	15	2.62	1.25
Active data points	17	2.35	1.57	18	2.73	1.46
Tiered Seating	18	2.50	1.53	16	2.70	1.41
Position of lectern	19	2.66	1.51	19	2.77	1.36
Natural lighting	20	2.89	1.54	17	2.72	1.34
Clock	21	3.13	1.58	21	3.12	1.63
Shape of room	22	3.19	1.66	22	3.83	1.55
Internal finishes (type)	23	3.50	1.68	23	3.84	1.54
Internal finishes (colour)	24	3.52	1.63	24	3.95	1.59
Ceiling height	25	3.58	1.67	25	4.33	1.73

Results are consistent with the results of Babey's (1991) survey of staff and students at the University of California, Davis Campus.

To answer the question "are the responses between the academic staff and students significantly different?", a number of statistical significance tests (t-tests) were undertaken. Firstly each variable was tested to determine if the individual design variable means of the academic staff and student samples differed significantly. That is to say that the null hypothesis being tested was:

H_0: $\grave{\imath}_1 = \grave{\imath}_2$ where:
$\grave{\imath}_1$ = design variable mean of the student sample; and
$\grave{\imath}_2$ = design variable mean of the academic staff sample.

Having adopted a significance level of 5% and using a two tailed test with infinite degrees of freedom (>120) as is seen in the results presented in Table 3, for the majority of design variables the null hypothesis was rejected ($t_{0.025\,,\,\infty} = 1.96$, Chatfield, 1983). However, for the design elements, air conditioning, clock, internal finishes (type), natural light, seating and writing space, lectern seating comfort, tiered

seating and ventilation, the null hypothesis was accepted. Of note is that for every design element relating to audio-visual equipment, the null hypothesis was rejected.

Table 3

Design Variable	Staff Mean	Students Mean	Difference	Test Statistic	Null Hypothesis
Acoustic quality of room	1.36	2.23	-0.88	7.34	Reject
Active data points	2.35	2.73	-0.38	2.20	Reject
Air conditioning	1.59	1.68	-0.09	0.83	Accept
Appropriateness of size	1.60	2.17	-0.57	4.85	Reject
Artificial lighting	1.85	2.38	-0.53	4.03	Reject
Audio quality of audio visual equipment	1.44	1.87	-0.43	4.07	Reject
Ceiling height	3.58	4.33	-0.76	3.91	Reject
Clock	3.13	3.12	0.01	0.06	Accept
Ease of accessibility to chair	1.87	2.45	-0.58	4.28	Reject
Ease of accessibility to room	1.80	2.50	-0.69	5.20	Reject
Internal finishes (type)	3.50	3.84	-0.34	1.85	Accept
Internal finishes (colour)	3.52	3.95	-0.43	2.38	Reject
Lighting control	1.68	2.50	-0.82	6.53	Reject
Natural lighting	2.89	2.72	0.17	1.04	Accept
Notebook computer / data projector	2.14	2.62	-0.48	3.05	Reject
Over head projector	1.29	2.39	-1.11	10.11	Reject
Amount of personal seating space	2.10	2.02	0.08	0.65	Accept
Amount of personal writing space	1.93	1.84	0.09	0.85	Accept
Position of lectern	2.66	2.77	-0.11	0.67	Accept
Seating comfort	1.99	1.79	0.20	1.74	Accept
Shape of room	3.19	3.83	-0.64	3.50	Reject
Television / Video cassette recorder	2.05	2.94	-0.89	5.77	Reject
Tiered seating	2.50	2.70	-0.20	1.23	Accept
Ventilation	1.56	1.70	-0.14	1.37	Accept
Visual quality of Audio visual equipment	1.25	1.99	-0.74	8.39	Reject

Correlation Coefficient	0.88	Count	25
Coefficient of Determination	0.77	Mean	-0.41
		Std Dev	0.37
		t_0=	-5.6

A t-test was then applied to the paired comparisons of staff and student means across all design variables. The null hypothesis in this instance being that each pair of means is equal for the entire set of design variables.

H_0: $ì_{1j} = ì_{2j}$ for all j where:
$ì_{1j}$ = mean of each design variable for the student sample; and
$ì_{2j}$ = mean of each design variable for the staff sample.

Again, in this instance the test statistic $|t_0|= 5.6$ and $t_{0.025\ ,\ 24} = 2.064$ (Chatfield, 1983) providing reasonable evidence that H_0 is untrue.

Critical Components of Tutorial Rooms

An analysis of the user opinions regarding critical components of tutorial rooms revealed similar findings to those of lecture theatres. As is seen in Table 4 below, students attributed most importance to air-conditioning, ventilation, seating space, writing space and seating comfort whereas academic staff attributed most importance to audio visual equipment with the overhead projector considered to be the most important design variable. In comparison to lecture theatres there was a slight reordering of design variables' ranked importance amongst academic staff and students, justifying the earlier decision to separate the two facilities in the questionnaire. As with lecture theatres, academic staff consistently rated the design variables as more important than did the students.

Table 4

Design Variable	Academic Staff (N=124)			Students (N=197)		
	Rank	Mean	Std Dev	Rank	Mean	Std Dev
Over head projector	1	1.27	0.59	7	2.16	1.24
Visual quality of Audio visual equipment	2	1.46	0.74	8	2.18	1.28
Ventilation	3	1.52	0.84	2	1.80	1.09
Appropriateness of size	4	1.57	0.80	6	2.05	1.09
Air conditioning	5	1.58	0.95	1	1.70	0.89
Flexibility	6	1.67	1.30	11	2.39	1.46
Amount of personal writing space	7	1.73	0.88	3	1.96	1.09
Audio quality of audio visual equipment	8	1.74	1.12	10	2.36	1.30
Acoustic quality of room	9	1.77	0.98	13	2.47	1.28
Amount of personal seating space	10	1.77	0.85	4	2.03	0.99
Ease of accessibility to room	11	1.79	1.10	15	2.59	1.34
Ease of accessibility to chair	12	1.87	1.11	14	2.54	1.35
Seating comfort	13	2.02	1.11	5	2.04	1.27
Lighting control	14	2.06	1.36	20	2.86	1.41
Television / Video cassette recorder	15	2.13	1.50	16	2.71	1.57
Artificial lighting	16	2.26	1.17	12	2.46	1.18
Notebook computer / data projector	17	2.35	1.51	18	2.80	1.39
Natural lighting	18	2.40	1.45	9	2.30	1.25
Active data points	19	2.48	1.50	17	2.79	1.43
Clock	20	3.12	1.67	19	2.81	1.54
Shape of room	21	3.13	1.70	22	3.81	1.72
Internal finishes (type)	22	3.58	1.78	23	3.85	1.60
Ceiling height	23	3.62	1.50	25	4.12	1.71
Internal finishes (colour)	24	3.68	1.78	24	3.89	1.71
Position of lectern	25	3.80	1.88	21	3.08	1.51

Similar significance tests were conducted on this data set as were performed previously to determine if the responses of the staff and students differed significantly.

The test statistics in Table 5 below reveal that for the majority of design elements, the null hypothesis was rejected ($t_{0.025, \infty} = 1.96$, Chatfield, 1983) and for the paired comparisons, the null hypothesis was also rejected $|t_0| = 4.91 > t_{0.025\ ,\ 24} = 2.064$ (Chatfield, 1983), thus providing reasonable evidence that the responses of the academic staff and students were significantly different at the 5% level.

Table 5

Design Variable	Staff Mean	Students Mean	Difference	Test Statistic	Null Hypothesis
Acoustic quality of room	1.77	2.47	-0.70	5.41	Reject
Active data points	2.48	2.79	-0.31	1.85	Accept
Air conditioning	1.58	1.70	-0.12	1.14	Accept
Appropriateness of size	1.57	2.05	-0.47	4.37	Reject
Artificial lighting	2.26	2.46	-0.20	1.48	Accept
Audio quality of audio visual equipment	1.74	2.36	-0.62	4.48	Reject
Ceiling height	3.62	4.12	-0.50	2.73	Reject
Clock	3.12	2.81	0.31	1.71	Accept
Ease of accessibility to chair	1.87	2.54	-0.67	4.75	Reject
Ease of accessibility to room	1.79	2.59	-0.80	5.69	Reject
Flexibility	1.67	2.39	-0.72	4.55	Reject
Internal finishes (type)	3.58	3.85	-0.27	1.38	Accept
Internal finishes (colour)	3.68	3.89	-0.22	1.08	Accept
Lighting control	2.06	2.86	-0.80	5.04	Reject
Natural lighting	2.40	2.30	0.10	0.66	Accept
Notebook computer / data projector	2.35	2.80	-0.45	2.70	Reject
Over head projector	1.27	2.16	-0.89	8.47	Reject
Amount of personal seating space	1.77	2.03	-0.25	2.37	Reject
Amount of personal writing space	1.73	1.96	-0.23	2.07	Reject
Position of lectern	3.80	3.08	0.72	3.71	Reject
Seating comfort	2.02	2.04	-0.02	0.18	Accept
Shape of room	3.13	3.81	-0.68	3.45	Reject
Television / Video cassette recorder	2.13	2.71	-0.58	3.30	Reject
Ventilation	1.52	1.80	-0.28	2.50	Reject
Visual quality of Audio visual equipment	1.46	2.18	-0.72	6.21	Reject

Correlation Coefficient	0.87	Count	25.00
Coefficient of Determination	0.76	Mean	-0.37
		Std Dev	0.38
		t_0=	-4.91

Critical Components Affecting Learning Experience

Table 6 below details academic staff and student responses in relation to how important they considered each design variable to be in terms of their effect on students' learning experience.

Table 6

	Academic Staff (N=112)			Students (N=187)		
Design Variable	**Rank**	**Mean**	**Std Dev**	**Rank**	**Mean**	**Std Dev**
Acoustic quality of room	1	1.38	0.79	6	2.11	1.25
Visual quality of audio visual equipment	2	1.42	0.71	7	2.13	1.19
Audio quality of audio visual equipment	3	1.47	0.96	9	2.20	1.18
Over head projector	4	1.55	0.89	8	2.16	1.17
Ventilation	5	1.56	0.96	2	1.82	1.14
Air conditioning	6	1.65	1.05	1	1.71	0.96
Amount of personal writing space	7	1.80	1.06	3	2.00	1.11
Seating comfort	8	1.86	1.09	5	2.07	1.29
Amount of personal seating space	9	1.90	1.07	4	2.00	1.04
Appropriateness of size	10	1.96	1.20	10	2.26	1.24
Ease of accessibility to chair	11	2.11	1.44	18	2.75	1.41
Ease of accessibility to room	12	2.12	1.46	19	2.78	1.45
Lighting control	13	2.14	1.22	17	2.74	1.44
Flexibility	14	2.18	1.27	20	2.83	1.53
Television / Video cassette recorder	15	2.20	1.33	13	2.59	1.33
Artificial lighting	16	2.32	1.27	12	2.51	1.36
Tiered Seating	17	2.36	1.34	15	2.60	1.45
Notebook computer / data projector	18	2.46	1.55	16	2.62	1.29
Natural lighting	19	2.52	1.46	14	2.59	1.51
Active data points	20	2.57	1.53	11	2.47	1.32
Position of lectern	21	3.51	1.79	21	2.95	1.62
Shape of room	22	3.54	1.80	23	3.80	1.81
Internal finishes (type)	23	4.16	1.76	24	4.09	1.79
Internal finishes (colour)	24	4.21	1.81	25	4.11	1.82
Ceiling height	25	4.22	1.76	26	4.25	1.92
Clock	26	4.32	1.99	22	3.38	1.75

Again it is readily apparent that the perceived importance attributed to each design variable differs between the two user groups, with academic staff consistently rating the majority of components as being more important than do the students. It is also apparent that there has been a reprioritisation of importance with respect to academic staff responses, however the students ranking appears not to have altered significantly.

Similar significance tests were also conducted on this data set as were performed previously. The test statistics below in Table 7 reveal that on an elemental basis, the null hypothesis (that the mean of the students responses and those of the staff were equal) was accepted more often than for the previous data sets, again $t_{0.025,\infty} = 1.96$, (Chatfield, 1983).

Table 7

Design Variable	Staff Mean	Students Mean	Difference	Test Statistic	Null Hypothesis
Acoustic quality of room	1.38	2.11	-0.73	5.99	Reject
Active data points	2.57	2.47	0.10	0.61	Accept
Air conditioning	1.65	1.71	-0.06	0.48	Accept
Appropriateness of size	1.96	2.26	-0.31	2.11	Reject
Artificial lighting	2.32	2.51	-0.18	1.17	Accept
Audio quality of audio visual equipment	1.47	2.20	-0.73	5.69	Reject
Ceiling height	4.22	4.25	-0.02	0.10	Accept
Clock	4.32	3.38	0.94	4.21	Reject
Ease of accessibility to chair	2.11	2.75	-0.65	3.79	Reject
Ease of accessibility to room	2.12	2.78	-0.67	3.86	Reject
Flexibility	2.18	2.83	-0.65	3.91	Reject
Internal finishes (type)	4.16	4.09	0.07	0.33	Accept
Internal finishes (colour)	4.21	4.11	0.10	0.45	Accept
Lighting control	2.14	2.74	-0.60	3.76	Reject
Natural lighting	2.52	2.59	-0.07	0.40	Accept
Notebook computer / data projector	2.46	2.62	-0.15	0.91	Accept
Over head projector	1.55	2.16	-0.61	4.94	Reject
Amount of personal seating space	1.90	2.00	-0.10	0.78	Accept
Amount of personal writing space	1.80	2.00	-0.20	1.51	Accept
Position of lectern	3.51	2.95	0.56	2.76	Reject
Seating comfort	1.86	2.07	-0.22	1.53	Accept
Shape of room	3.54	3.80	-0.27	1.23	Accept
Television / Video cassette recorder	2.20	2.59	-0.39	2.49	Reject
Tiered seating	2.36	2.60	-0.25	1.47	Accept
Ventilation	1.56	1.82	-0.26	2.05	Reject
Visual quality of Audio visual equipment	1.42	2.13	-0.71	6.31	Reject

Correlation Coefficient	0.92	Count	26
Coefficient of Determination	0.84	Mean	-0.23
		Std Dev	0.40
		t_0=	-2.95

This apparent convergence of users' opinions is further exemplified by the result of the test statistic for the paired comparisons, where $t_{0\ (\text{Lecture Theatres})} = -5.6$ and $t_{0\ (\text{Tutorial Rooms})} = -4.9$, $t_{0\ (\text{Learning Experience})} = -2.95$. Whilst this is still reasonable evidence to suggest that the null hypothesis was untrue ($|t_0| = 2.95 > t_{0.025,\ 25} = 2.060$) there is a clear convergence of opinion with regard to the perceived importance of design variables in terms of their effect on learning experience.

Analysis within the Academic Staff User Group

Having established that the users' opinions are significantly different (at the 5% level), attention is turned to analysis within the individual user groups. More specifically, how have the opinions varied when respondents are asked to consider students' learning experience as opposed to the general features / facilities of rooms?

Table 8 below summarises academic staff members' responses to questions 7, 8 and 9 contained in the questionnaire. Clearly there are differences in ranking but the variations are less apparent when considering the mean scores.

Table 8

Staff	Lecture Theatres			Tutorial Rooms			Learning Experience		
Design Variable	**Rank**	**Mean**	**Std. Dev.**	**Rank**	**Mean**	**Std. Dev.**	**Rank**	**Mean**	**Std. Dev.**
Acoustic quality of room	3	1.36	0.69	9	1.77	0.98	1	1.38	0.79
Visual quality of Audio visual equipment	1	1.25	0.45	2	1.46	0.74	2	1.42	0.71
Audio quality of audio visual equipment	4	1.44	0.82	8	1.74	1.12	3	1.47	0.96
Over head projector	2	1.29	0.68	1	1.27	0.59	4	1.55	0.89
Ventilation	5	1.56	0.83	3	1.52	0.84	5	1.56	0.96
Air conditioning	6	1.59	1.01	5	1.58	0.95	6	1.65	1.05
Amount of personal writing space	12	1.93	0.96	7	1.73	0.88	7	1.80	1.06
Seating comfort	13	1.99	1.05	13	2.02	1.11	8	1.86	1.09
Amount of personal seating space	15	2.10	1.05	10	1.77	0.85	9	1.90	1.07
Appropriateness of size	7	1.60	0.89	4	1.57	0.80	10	1.96	1.20
Ease of accessibility to chair	11	1.87	1.11	12	1.87	1.11	11	2.11	1.44
Ease of accessibility to room	9	1.80	1.07	11	1.79	1.10	12	2.12	1.46
Lighting control	8	1.68	0.94	14	2.06	1.36	13	2.14	1.22
Flexibility	-	-	-	6	1.67	1.30	14	2.18	1.27
Television / Video cassette recorder	14	2.05	1.32	15	2.13	1.50	15	2.20	1.33
Artificial lighting	10	1.85	1.14	16	2.26	1.17	16	2.32	1.27
Tiered seating	18	2.50	1.53	-	-	-	17	2.36	1.34
Notebook computer / data projector	16	2.14	1.52	17	2.35	1.51	18	2.46	1.55
Natural lighting	20	2.89	1.54	18	2.40	1.45	19	2.52	1.46
Active data points	17	2.35	1.57	19	2.48	1.50	20	2.57	1.53
Position of lectern	19	2.66	1.51	25	3.80	1.88	21	3.51	1.79
Shape of room	22	3.19	1.66	21	3.13	1.70	22	3.54	1.80
Internal finishes (type)	23	3.50	1.68	22	3.58	1.78	23	4.16	1.76
Internal finishes (colour)	24	3.52	1.63	24	3.68	1.78	24	4.21	1.81
Ceiling height	25	3.58	1.67	23	3.62	1.50	25	4.22	1.76
Clock	21	3.13	1.58	20	3.12	1.67	26	4.32	1.99

Analysis within Students User Group

A similar analysis was also undertaken regarding the students' perceptions of the importance of design variables in terms of their effect on learning experience and those regarding the general features of learning environments. As revealed in Table 9, there appears to be less variability in both rank and mean scores than occurred with the academic staff .

Table 9

Students	Lecture Theatres			Tutorial Rooms			Learning Experience		
Design Variable	**Rank**	**Mean**	**Std. Dev.**	**Rank**	**Mean**	**Std. Dev.**	**Rank**	**Mean**	**Std. Dev.**
Air conditioning	1	1.68	0.95	1	1.70	0.89	1	1.71	0.96
Ventilation	2	1.70	1.02	2	1.80	1.09	2	1.82	1.14
Amount of personal seating space	7	2.02	0.98	4	2.03	0.99	3	2.00	1.04
Amount of personal writing space	4	1.84	0.95	3	1.96	1.09	4	2.00	1.11
Seating comfort	3	1.79	0.97	5	2.04	1.27	5	2.07	1.29
Acoustic quality of room	9	2.23	1.41	13	2.47	1.28	6	2.11	1.25
Visual quality of Audio visual equipment	6	1.99	1.11	8	2.18	1.28	7	2.13	1.19
Over head projector	11	2.39	1.25	7	2.16	1.24	8	2.16	1.17
Audio quality of audio visual equipment	5	1.87	1.03	10	2.36	1.30	9	2.20	1.18
Appropriateness of size	8	2.17	1.17	6	2.05	1.09	10	2.26	1.24
Active data points	18	2.73	1.46	17	2.79	1.43	11	2.47	1.32
Artificial lighting	10	2.38	1.19	12	2.46	1.18	12	2.51	1.36
Natural lighting	17	2.72	1.34	9	2.30	1.25	13	2.59	1.51
Television / Video cassette recorder	20	2.94	1.39	16	2.71	1.57	14	2.59	1.33
Tiered seating	16	2.70	1.41	-	-	-	15	2.60	1.45
Notebook computer / data projector	15	2.62	1.25	18	2.80	1.39	16	2.62	1.29
Lighting control	14	2.50	1.27	20	2.86	1.41	17	2.74	1.44
Ease of accessibility to chair	12	2.45	1.29	14	2.54	1.35	18	2.75	1.41
Ease of accessibility to room	13	2.50	1.28	15	2.59	1.34	19	2.78	1.45
Flexibility	-	-	-	11	2.39	1.46	20	2.83	1.53
Position of lectern	19	2.77	1.36	21	3.08	1.51	21	2.95	1.62
Clock	21	3.12	1.63	19	2.81	1.54	22	3.38	1.75
Shape of room	22	3.83	1.55	22	3.81	1.72	23	3.80	1.81
Internal finishes (type)	23	3.84	1.54	23	3.85	1.60	24	4.09	1.79
Internal finishes (colour)	24	3.95	1.59	24	3.89	1.71	25	4.11	1.82
Ceiling height	25	4.33	1.73	25	4.12	1.71	26	4.25	1.92

The consistency of response is further exemplified by the significance tests on the paired comparisons outlined in Table 10. In fact in the case of both lecture theatres and tutorial rooms, when the students' responses regarding the importance of room features generally are compared to those emphasising students learning experience, the null hypothesis (that the means are equal) was accepted ($|t_0| = 1.71$ and $1.11 < t_{0.025\,,\,24} = 2.064$) with the result being significant at the 5% level.

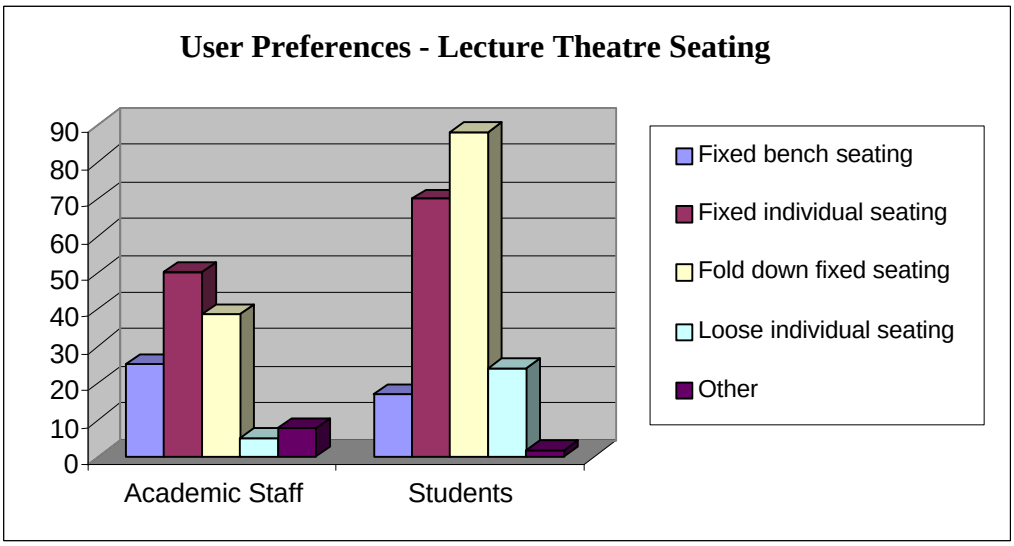
Table 10

Design Variable	**Lecture Theatres Mean**	**Tutorial Room Mean**	**Learning Experience Mean**	**Difference** (Learning Experience & Lecture Theatres)	**Difference** (Learning Experience & Tutorial Rooms)
Acoustic quality of room	2.23	2.47	2.11	-0.12	-0.35
Active data points	2.73	2.79	2.47	-0.26	-0.32
Air conditioning	1.68	1.70	1.71	0.03	0.01
Amount of personal seating space	2.02	2.03	2.00	-0.02	-0.03
Amount of personal writing space	1.84	1.96	2.00	0.16	0.04
Appropriateness of size	2.17	2.05	2.26	0.10	0.22
Artificial lighting	2.38	2.46	2.51	0.12	0.05
Audio quality of audio visual equipment	1.87	2.36	2.20	0.33	-0.16
Ceiling height	4.33	4.12	4.25	-0.09	0.12
Clock	3.12	2.81	3.38	0.26	0.57
Ease of accessibility to chair	2.45	2.54	2.75	0.31	0.21
Ease of accessibility to room	2.50	2.59	2.78	0.29	0.20
Flexibility	-	2.39	2.83	-	0.45
Internal finishes (colour)	3.95	3.89	4.11	0.16	0.21
Internal finishes (type)	3.84	3.85	4.09	0.25	0.24
Lighting control	2.50	2.86	2.74	0.24	-0.12
Natural lighting	2.72	2.30	2.59	-0.13	0.29
Notebook computer / data projector	2.62	2.80	2.62	-0.01	-0.18
Over head projector	2.39	2.16	2.16	-0.23	0.00
Position of lectern	2.77	3.08	2.95	0.18	-0.13
Seating comfort	1.79	2.04	2.07	0.28	0.03
Shape of room	3.83	3.81	3.80	-0.03	-0.01
Television / Video cassette recorder	2.94	2.71	2.59	-0.34	-0.12
Tiered seating	2.70	-	2.60	-0.10	-
Ventilation	1.70	1.80	1.82	0.12	0.02
Visual quality of audio visual equipment	1.99	2.18	2.13	0.14	-0.04
Correlation Coefficient	0.966	0.955	Count	25	25
Coefficient of Determination	0.933	0.911	Mean	0.07	0.05
			Std Dev	0.19	0.22
			t_0	1.713	1.111

User Preferences – Seating and Writing Surfaces

Figure 1 below outlines the seating preferences of both academic staff and students in lecture theatres.

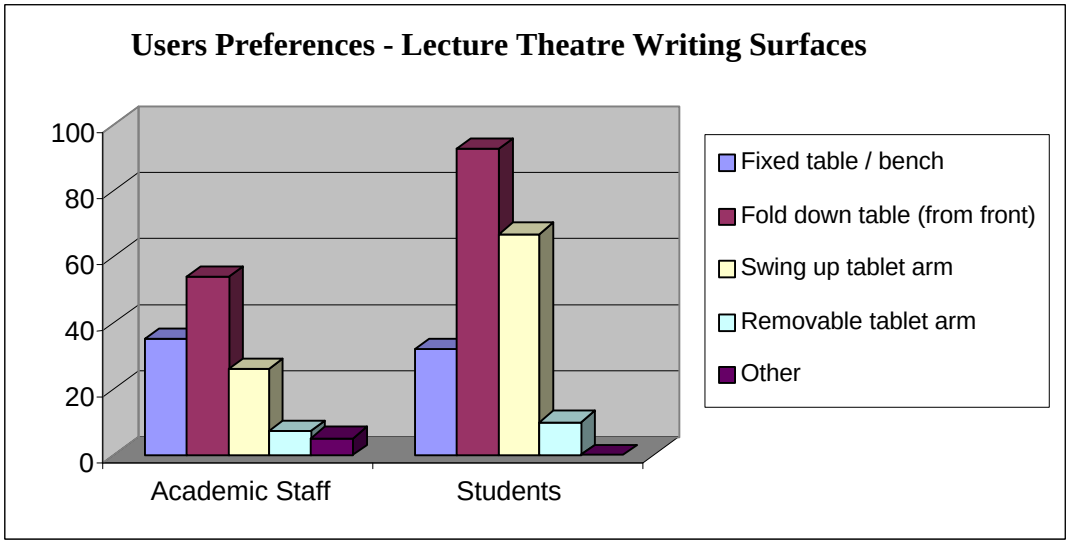
Figure 1



Clearly the users prefer fixed seating, with the fold down style being prefered by the students.
This is at odds with the design principles presented by Owu (1991) who suggests that fixed tablet arm seats are appropriate in larger lecture theatres.

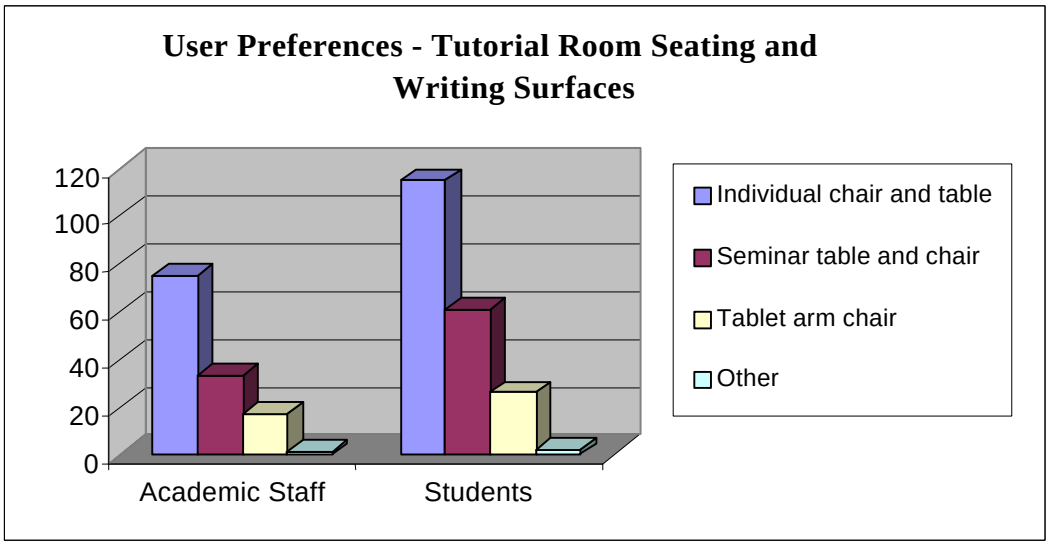
Figure 2 outlines the user group preferences in relation to lecture theatre writing surfaces, with fold down tables (from front) being preferred by both staff and students. Swing up tablet arms were the second most popular writing surface amongst the students which is surprising considering that anecdotal evidence suggested that students did not like the swing up tablet arms due to their small writing surface and instability.

Figure 2



In relation to user preferences for seating and writing surfaces in tutorial rooms, there is a clear preference amongst staff and students for individual chairs and tables as depicted in Figure 3.

Figure 3



This is consistent with much of the recent literature which consistently espouses designing for flexibility. Individual chairs and tables not only provide students with a substantially larger writing surface than afforded by a tablet arm chair, they also facilitate the easy reconfiguration of space more so than do larger seminar tables. Perhaps the only drawback of using individual chairs and tables in lieu of tablet arm chairs is that the room capacity is reduced, potentially having serious repurcussions on the University timetable.

Analysis of Respondent Comments

Section 3 of the questionnaire provided respondents with the opportunity to make comments regarding the general teaching facilities at UniSA. Content analysis of the responses was undertaken in an endeavour to ascertain critical issues amongst the users.

Of the 120 academic staff respondents, 55 or 46% took the opportunity to complete Section 3, with 84% of the comments being critical of one or more aspects of the facilities at UniSA.

The major issues raised are as follows:

- Inadequate provision of notebook computers and data projectors in lecture theatres (11% of comments);
- Poorly maintained facilities – largely audio visual related maintenance (11%);
- Inadequate provision of quality overhead projectors (9%);
- Poor quality of furniture in the tutorial rooms (9%);
- Inadequate provision of televisions / video cassette recorders (7%); and
- Erratic air conditioning with a lack of user control (7%).

The highest proportion of comments (20%) were simply general comments in relation to the poor standard of the facilities but in relation to specific issues, it is clear that the audio-visual equipment dominated the responses.

Of the 205 student responses, 69 (34%) took the opportunity to comment with regard to the general facilities at UniSA. 72% of the comments made by students were critical of some aspect of the general facilities with the residual comments being either complimentary (9%) or ambivalent (26%) towards the general teaching facilities.

The critical issues amongst students were as follows:

- Poor seating comfort, particularly in lecture theatres (14% of comments);
- Poor ventilation in lecture theatres (13%);
- Inadequate provision of computer pools (12% of comments - 77% of which were made by students at City West);
- Erratic air conditioning with students complaining of being either too hot or too cold (8%);
- Inadequate writing space in both lecture theatres and tutorial rooms (8%); and
- Poor quality of the furniture generally (6%).

Clearly the issues amongst students differ from those of the academic staff with the comments closely aligned to the components of the facilities each of the user groups considered to be most important.

Discussion and Conclusions

The research has revealed that none of the design variables were considered by the users to be unimportant indicating that all should be integral elements of teaching and learning environments in the University of South Australia. Whilst the academic staff tended to prioritise audio visual equipment as being most important, students prioritised environmental factors such as air conditioning and ventilation, followed by their immediate environment of seating and writing surfaces. Clearly both parties emphasise 'the tools of the trade', students prioritising room components that aid learning and staff prioritising room components which facilitate teaching. The content analysis of responses to Section 3 of the survey questionnaire confirms these priorities.

The research has revealed a number of interesting findings.

1. Staff consistently rated design variables as more important than did the students. As previously stated, this is consistent with the research undertaken by Babey (1991). A possible explanation is that despite the majority of student - teacher interaction taking place in either the lecture theatre or the tutorial room, the student does a tremendous amount of learning outside of these environments. Therefore students place a lesser importance on the in-house facilities in recognition of the fact that a great deal of their learning is done elsewhere. Conversely, little teaching is performed outside of the lecture theatre or tutorial room and hence this environment is seen as being more critical by the academic staff.

2. The lowest ranked variables amongst both staff and students were consistently the shape of the room, internal finishes (both type and colour) and ceiling height, with both user groups being indifferent (neutral) in relation their importance. The researchers consider that the user responses to these design variables perhaps belie their importance. Two possible explanations are offered for their low ranking. Firstly, with respect to the shape of the room and the ceiling height, it may not be overtly apparent to users how these can impact on the teaching and learning environment. Secondly, with respect to finishes, it is suggested that respondents are largely influenced by their surroundings and as the colours and textures used in the University are typically neutral, they have not attracted significant attention. It is suggested that if the finishes were deteriorating or particularly offensive, significant negative comment would have been received and potentially greater importance would have been attributed to these elements.

3. Despite changes in pedagogy and advances in technology the academic staff at the University of South Australia still consider the overhead projector to be the most important audio visual teaching aid. This could be interpreted to mean that academic staff clearly have a preference for older technology as their primary mode of delivery, or alternatively academic staff may believe that in the absence of reliable high technology teaching tools, the over head projector is a must. It is possible that the practical difficulty of high-technology audio-visual presentation reinforces many academics' prejudices against it. More research is required here to draw reliable conclusions.

4. When asked to consider students' learning experience, student responses were not significantly different from their responses regarding the features and facilities of rooms generally. On the other hand, the academic staff responses were significantly different, with the audio-visual elements still considered to be most important on average. As expected, the emphasis in the questioning did elicit a reprioritisation in design variable importance amongst the academic staff, however the continued prioritisation of audio- visual equipment might suggest that the staff still emphasised their teaching rather than students learning.

Perhaps the most important finding of this research is the fact that from the students perspective, most design variables are considered to be important in terms of their effect on learning experience, thus confirming the findings of Flemming and Storr's (1999) study. Not only do students consider this to be the case, but also the academic staff. This general perception amongst the users highlights a shortfall in the literature that ignores the importance of 'place' in the context of learning.

Whilst both user groups should be consulted in the design and refurbishment projects, clearly facilities managers should pay particular attention to academic staff when considering audio visual elements and the students when considering seating and writing surfaces. Furthermore, given the different perspectives of each user group, any applied benchmarking techniques which assess fitness for purpose should involve both user groups.

Based on the research findings within, the following are suggested for facilities managers at UniSA to improve user satisfaction.

- Ensure future lecture theatres comprise fold down fold down fixed seating with a fold down table. Swing up tablet arm chairs are to be avoided.
- Ensure the provision of overhead projectors in all general teaching facilities.
- Replace all old overhead projectors with the new twin globe variety.
- Ensure the facilities (especially audio visual related equipment) are adequately maintained and cleaned. This includes cleaning whiteboards, checking overhead projector globes and removing broken furniture.
- Ensure that the tutorial rooms comprise individual chairs and tables, again avoiding the use of tablet arm chairs.
- Investigate ways to improve ventilation in the lecture theatres.
- Investigate ways to implement user controls in relation to air conditioning.
- Engage in a process of consultation with the academic staff to determine how best to address the immediate audio visual equipment issues.
- Seek student input regarding the selection of comfortable seating.

If the above issues are addressed, students' learning experience is likely to be enhanced, supporting the strategic intent of the University.

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